U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-257 302

# An Investigation of Pesticide Pollution in the Lower Colorado River Basin - 1973

National Field Investigations Center-Denver, Colo

Prepared for

Environmental Protection Agency, San Francisco, Calif Region IX

Dec 73

260004

PB 257 302

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

| BIBLIOGRAPHIC DATA SHEET | 1. Report No. EPA-330/2-73/007 | 2. | 3. Recipient's Accession No. PB-257 302 |
|---|---|---|---|
| 4. Title and Subtitle<br>An Investigation of Pesticide Pollution in the Lower Colorado River Basin - 1973 | | | 5. Report Date<br>Dec 73<br>6. |
| 7. Author(s) | | | 8. Performing Organization Rept. No. |
| 9. Performing Organization Name and Address<br>National Field Investigations Center-Denver, Colorado | | | 10. Project/Task/Work Unit No.<br>11. Contract/Grant No. |
| 12. Sponsoring Organization Name and Address | | | 13. Type of Report & Period Covered<br>14. |

15. Supplementary Notes
Prepared in cooperation with Environmental Protection Agency, San Francisco, California. Region IX.

16. Abstracts
The Colorado River forms the boundary between Arizona and California from near Needles, California to near Yuma, Arizona. The report is an investigation of the water quality of the Lower Colorado River and it concludes that pollution problems were caused by indiscriminate pesticide application practices on irrigated lands in both Arizona and California.

17. Key Words and Document Analysis. 17a. Descriptors
*Water pollution,
*Pesticides,
*Colorado River Basin,

Catfishes,
Residues,
Sediments,
Irrigation,
Stream flow,
Monitoring,
Tables(data),
Arizona,
California.

17b. Identifiers/Open-Ended Terms

*Water quality data.

17c. COSATI Field/Group 13 B

18. Availability Statement
National Technical Information Service
Springfield, Virginia 22161

19. Security Class (This Report) UNCLASSIFIED
21. No. of Pages 47p
20. Security Class (This Page) UNCLASSIFIED
22. Price 4.00/2.25

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

EPA-330/2-73-007

S-3

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

# REPORT ON

# AN INVESTIGATION OF PESTICIDE POLLUTION

# IN THE

# LOWER COLORADO RIVER BASIN - 1973

National Field Investigations Center-Denver
Denver, Colorado
and
Region IX
San Francisco, California
December 1973

TABLE OF CONTENTS


| | Page |
|---|---|
| LIST OF TABLES | iii |
| LIST OF FIGURES | iii |
| GLOSSARY OF TERMS | iv |
| I. INTRODUCTION | 1 |
| II. SUMMARY AND CONCLUSIONS | 3 |
| III. STREAM SURVEY | 5 |
| A. BIOLOGICAL STUDIES | 5 |
| B. CHEMICAL STUDIES | 7 |
| C. WATER QUALITY | 8 |
| IV. APPLICATION TECHNIQUES, TYPES OF PESTICIDE MATERIALS USED AND CURRENT AGRICULTURAL PRACTICES | 9 |
| V. METHODS AND MATERIALS | 12 |
| A. BIOLOGY | 12 |
| B. CHEMISTRY | 13 |
| REFERENCES | 17 |
| APPENDIX | 18 |

## LIST OF TABLES


| Table No. | | Page |
|---|---|---|
| 1 | SAMPLING STATIONS, LOWER COLORADO RIVER PESTICIDE INVESTIGATION | 19 |
| 2 | AChE ACTIVITY LEVELS OF EXPOSED CHANNEL CATFISH LOWER COLORADO RIVER BASIN JULY TO SEPTEMBER 1973 | 21 |
| 3 | PESTICIDE RESIDUE ANALYSES OF NATIVE FISH LOWER COLORADO RIVER BASIN JULY TO SEPTEMBER 1973 | 22 |
| 4 | RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES LOWER COLORADO RIVER BASIN JULY TO SEPTEMBER 1973 | 23 |
| 5 | RESULTS OF ANALYSES OF WATER GRAB SAMPLES LOWER COLORADO RIVER BASIN JULY TO SEPTEMBER 1973 | 35 |
| 6 | RESULTS OF PESTICIDES ANALYSES TILE DRAINAGE LOWER COLORADO RIVER | 36 |
| 7 | RESULTS OF SEDIMENT ANALYSES FOR TOXAPHENE RESIDUES LOWER COLORADO RIVER BASIN JULY TO SEPTEMBER 1973 | 37 |
| 8 | WATER QUALITY DATA, LOWER COLORADO RIVER BASIN JULY TO SEPTEMBER 1973 | 38 |
| 9 | EFFICIENCY OF RESIN COLUMNS FOR RECOVERY OF PESTICIDES (0.1 mg/l SOLUTIONS) FROM WATER | 39 |


## LIST OF FIGURES


| Figure No. | | Follows Page |
|---|---|---|
| 1 | Areas of Pesticide Application | 1 |
| 2 | Sampling Stations in the Lower Colorado River Basin | 6 |

## GLOSSARY

°C - Temperature in degrees centigrade = 5/9 (°F-32)

cfs - Flow rate in cubic feet per second = 0.0283 cubic meters per second = 28.3 liters per second

cm - Length in centimeters = 0.3937 inches = 0.03281 feet

DO - Dissolved Oxygen

°F - Temperature in degrees Fahrenheit = 1.8°C + 32

ft - Length in feet = 0.3048 meters

g - Weight in grams = 0.0353 ounces

gal. - Volume in gallons = 3.785 liters

hr - Time in hours

in. - Length in inches = 2.54 centimeters

kg - Weight in kilograms = 2.21 pounds

km - Distance in kilometers = 0.621 miles

l - Volume in liters = 0.2642 gallons

$m^3$/sec - Flow rate in cubic meters per second = 22.8 million gallons per day = 35.3 cubic feet per second

mg - Weight in milligrams = 1/1000 of a gram

mg/l - Concentration in milligrams per liter

µg/g - Concentration in micrograms per gram = parts per million

ml - Volume in milliliters = 1/1000 of a liter

pH - Logarithm (base 10) of the reciprocal of the hydrogen-ion concentration

RM - River mileage (e.g., RM 184.2) denoting the distance in miles upstream from the mouth of the Colorado River

sec - Time in seconds

# I. INTRODUCTION

The Colorado River forms the boundary between Arizona and California from near Needles, California to near Yuma, Arizona. The river also forms the boundary between the United States and Mexico from near Yuma, Arizona to San Luis, Sonora.

In 1968 the Federal Water Pollution Control Administration conducted an investigation of the water quality of the Lower Colorado River and concluded that pollution problems were caused by indiscriminate pesticide application practices on irrigated lands in both Arizona and California from Parker Dam to the Southerly International Border.[1/] The major applications of these pesticides reportedly occurred in five major irrigation areas (Colorado River Indian Reservation, Palo Verde Irrigation District, Yuma Project Reservation Division, Yuma Project Valley Division and the Welton-Mohawk Project) [Figure 1].

Subsequent to 1968, only limited pesticide analyses were made even though through the years the total pesticide usage was known to have increased. As a result of this paucity of data and the concern that a more severe problem may have been present, the Environmental Protection Agency, Office of Enforcement in Washington, D.C. and the Director, Enforcement Division, Region IX, requested NFIC-Denver to undertake a survey of the Lower Colorado River and the major irrigation drains from Headgate Rock Dam to the Southerly International Boundary.

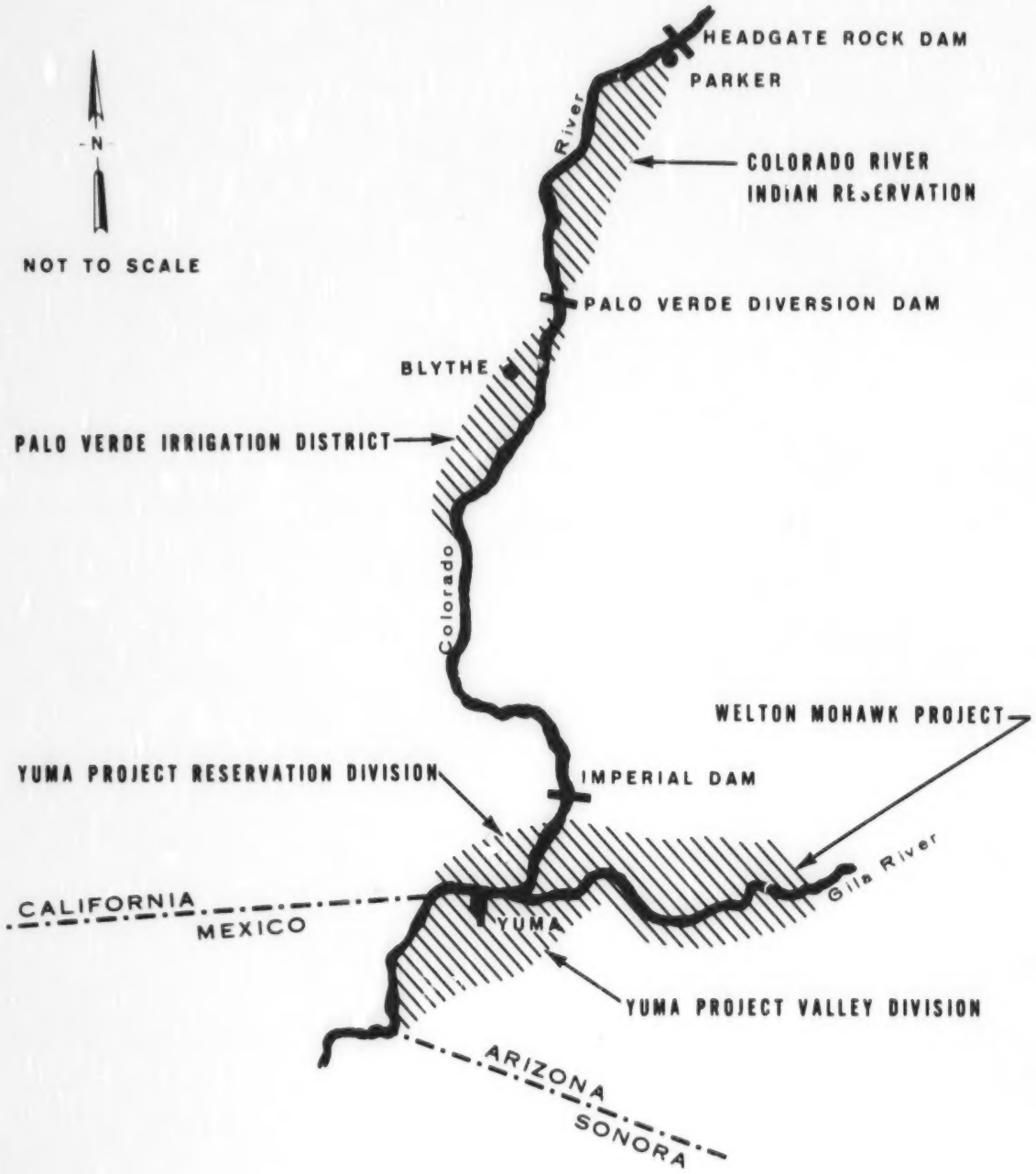


Figure 1. Areas of Pesticide Application

The investigations were conducted 20 July through 9 September 1973, and concentrated on the following objectives:

1. Assess the pesticide pollution problem in the Lower Colorado River.
2. Determine if Arizona and California Water Quality Standards are being violated by discharges of pesticides (biocides) into the Lower Colorado River.
3. Determine if pesticide concentrations are interferring with the water uses of the Lower Colorado River.
4. Determine the necessity of pollution abatement and recommend control measures as appropriate.

In the course of these investigations, valuable information and assistance were received from private citizens, pesticides distributors, and municipal, county, state and federal agencies. The Surveillance and Analysis Division, Region IX, EPA provided liaison between NFIC-Denver and cooperating Federal agencies. The cooperation extended by these individuals is gratefully acknowledged.

## II. SUMMARY AND CONCLUSIONS

During the Summer of 1973, an extensive study was conducted to assess the pesticide pollution problem of the Lower Colorado River. The study area included the River from Headgate Rock Dam to the Southerly International Boundary and major irrigation return drains serving five large irrigation areas in Arizona and California. Biological studies included the controlled *in situ* exposure of channel catfish at 17 stations to assess potential toxic effects of pesticides and the collection of native fish for pesticide residue examinations. Continuous water quality sampling was conducted at 10 stream and drain locations for evaluation of pesticide concentrations. In addition, water and sediment grab samples were collected at various locations for pesticide analysis. A summary of the findings is as follows:

1. Normal acetylcholinesterase (AChE) activity of a control group of channel catfish (*Ictalurus punctatus*) ranged from 1.21 to 1.66 micromoles of acetylcholine hydrolyzed per hour per milligram of brain tissue. Fish exposed in the study area exhibited an activity range of 1.23 to 1.59 micromoles of acetylcholine hydrolyzed per hour per milligram of brain tissue, well within the normal range. Organophosphate or carbamate pesticides were not present in the river in sufficient quantities to be harmful to fish.

2. Analyses of native fish indicated that contamination by organo-chlorine pesticides has been insignificant.

3. Of 140 water samples collected continuously by polymeric

adsorbent resins, none contained pesticide residues at significant levels.

4. Grab samples of water collected monthly from eight locations not continuously sampled contained no detectable pesticide residues. Sediments from eight locations were analyzed for toxaphene with none being present at detectable levels.

5. No pesticides were detected in representative samples of water collected from tile drains in the study area.

6. From the data contained in this report, the conclusion is made that a pesticide pollution problem did not exist in the Lower Colorado River during the study period. Additionally, data on organo-chlorine pesticides indicates that these compounds have not been present for the past one to three years in quantities sufficient to contaminate fish. Thus, the Water Quality Standards of Arizona and California for pesticides (biocides) were not violated.

7. Although total pesticide usage and the acreage of irrigated land has climbed upward in recent years, changes in agricultural practices have taken place to lessen the likelihood of contamination of the Colorado River by pesticides.

8. The improved pesticide application practices observed during the course of this investigation and the very limited concentrations of pesticides detected in the Colorado River, even though pesticide usage has increased, attest to the fact that receiving waters can be protected from pesticides pollution by careful application practices. Stringent permit limitations on the agricultural discharge of pesticides are thus justifiable.

## III. STREAM SURVEY

Investigations of the possible pesticide contamination of the Lower Colorado River, from Headgate Rock Dam (RM 184.2) to the Southerly International Boundary (RM 22.8), and of the major agricultural irrigation return drains [Table 1] were conducted from 20 July to 9 September 1973. This time period corresponds to the principal cotton growing season when pesticide applications are the heaviest and most frequent.

The Arizona and California Water Quality Standards contain basic standards applicable to all waters of the States that require freedom "from toxic, corrosive, and other deleterious substances attributable to domestic or industrial waste or other controllable sources at levels or combinations sufficient to be toxic to human, animal, plant or aquatic life..."[2,3/] In this investigation, emphasis was placed on determining adverse effects to the aquatic biota by pesticide residues in the water.

### A. BIOLOGICAL STUDIES

Pesticide use data for the Lower Colorado River Basin indicated that in recent years there has been a significant increase in the use of readily degradable organo-phosphate and carbamate pesticides in addition to the continued use of persistant organo-chlorine compounds. With this in mind, biological studies centered around the fact that these newer compounds were designed to inhibit acetylcholinesterase (AChE), an enzyme essential in the transmission of nervous impulses from the brain to various bodily organs.

Channel catfish were exposed *in situ* at 17 stations [Figure 2 and Table 1] for periods of 3 to 14 days. After all fish had been removed from a station, a new group was exposed. Fish were kept at each station for 52 days.

AChE activity is expressed as micromoles of acetylcholine hydrolyzed per hour per milligram of wet brain tissue. During the sampling period, 63 unexposed control fish were analyzed to establish a normal range of AChE activity for the test fish. The normal range for unexposed channel catfish was 1.21 to 1.66 [Table 2]. Ninety-five percent of the fish exposed in the survey area had activities ranging from 1.23 to 1.59. AChE activities were considered to be abnormally low if they were less than 1.13 (80 percent of the control mean of 1.41). Only three of the 146 samples analyzed fell into this category, having activities of 1.08, 1.08 and 1.11. Since all three samples were collected from different stations on different dates and none of the low values were repeated at a later date, it was concluded that these values do not reflect substantial water quality degradation.

The remaining AChE test data [Table 2] indicate that at no time during the sampling period was an AChE inhibiting substance present in the water in sufficient concentrations to have an acutely toxic effect (severe stress or death within 14 days) on the test animals.

Collections were made of native fish from the Palo Verde Diversion Dam area, Imperial Dam area, Mittry Lake (an ox-bow lake near Imperial Dam) and the Yuma Project Valley Division Main Drain. These fish were analyzed for organo-chlorine pesticide residues in the tissue. Only DDT

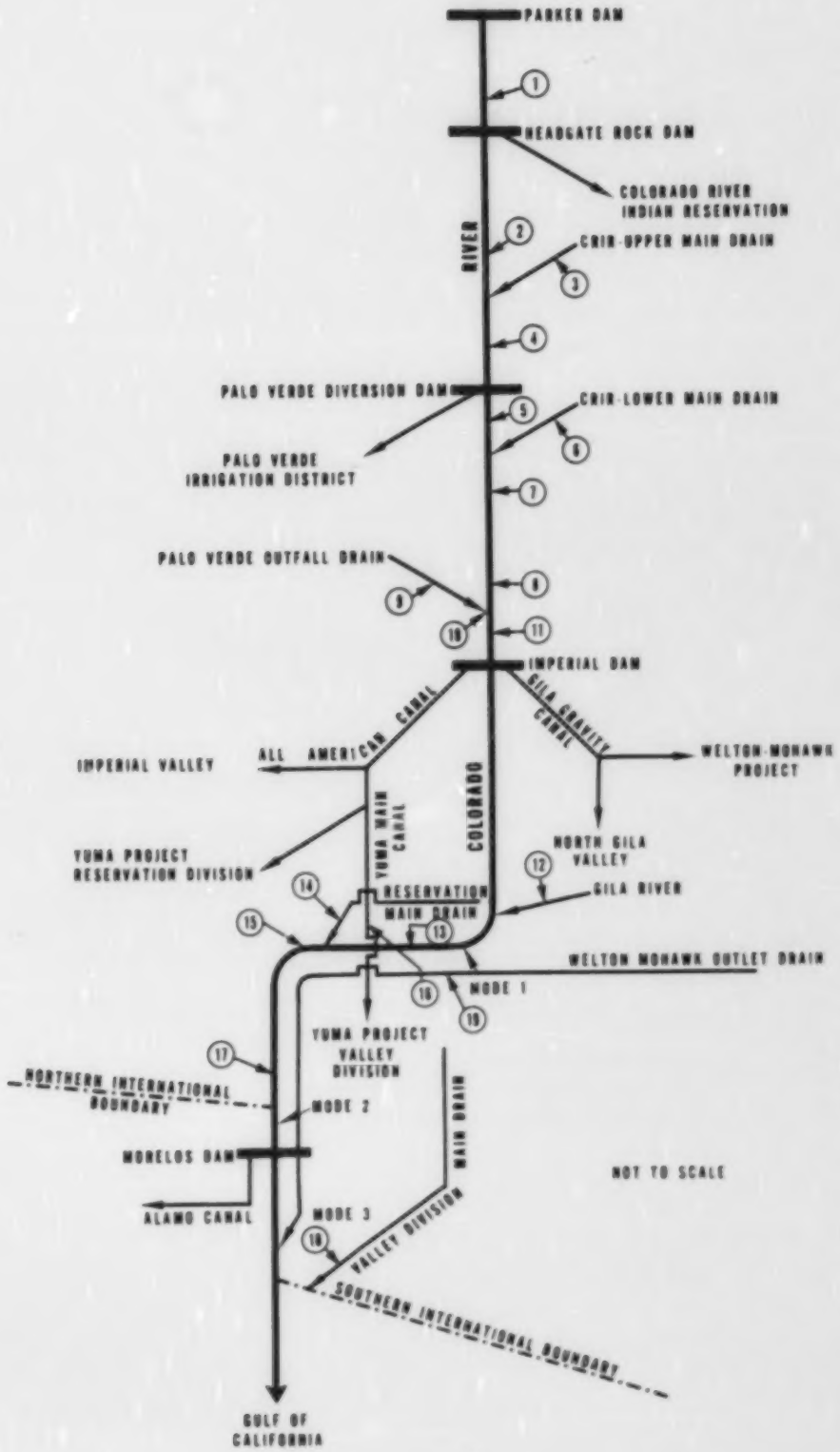


Figure 2. Schematic of Irrigation Diversions, Drains and Sampling Stations - Lower Colorado River Pesticide Pollution Investigation

was detected [Table 3] (in fish from the Yuma Project Valley Division Main Drain). Interpreting these results in terms of biomagnification (the accumulation and retention of a pesticide by an organism) indicates that organo-chlorine pesticide concentrations in the water and foodchain were insignificant during the preceding year. Studies by Macek, et al, indicate that within six months to one year, flesh and viscera of fish can be purged of pesticides.[4/] These laboratory studies corroborate the observed purging and reduced exposure of native fish in the Lower Colorado River during the period from 1968 to 1973.

B. CHEMICAL STUDIES

To evaluate pesticide residues in the water, automatic sampling units were installed at ten sampling sites [Figure 2 and Table 1]. Samplers were operated continuously from 20 July to 9 September 1973 at eight sites with a ninth sampler alternated between Stations 13 and 19 (see Section IV). Samples were collected by two methods: (1) by passage of water through a polymeric adsorbent resin, and (2) by liquid composites. A total of 140 resin samples and 22 liquid composite samples were analyzed. No pesticide residues were detected in any sample analyzed [Table 4].

Liquid grab samples collected monthly from eight areas not continuously sampled contained no pesticide residues at detectable levels [Table 5].

Discharges from three tile drains on the Colorado River Indian

Reservation (CRIR) and from two tile drains in the Palo Verde Irrigation District (PVID) were analyzed for pesticide content. Pesticides were not present in detectable concentrations [Table 6].

Sediment samples were collected from eight areas and analyzed for toxaphene content [Table 7]. None was present at a detectable level.

A review by Bell of water quality data and pesticide production and sales statistics, on a nationwide basis, indicates a general trend toward reduced usage of persistent pesticides and concomitant reductions in concentrations of persistent pesticides in surface streams.[5/]

C. WATER QUALITY

Water quality characteristics (temperature, DO, and pH) of the study area were recorded. Temperatures ranged from 22 to 37°C (72 to 99°F), DO ranged from 2.6 mg/l to 25 mg/l and pH ranged between 7.1 and 8.6 [Table 8]. The alkalinity of the waters of the study area (as indicated by generally high pH values) would cause the rapid degradation of organo-phosphate and carbamate pesticides.

A general increase in temperature was noted from Headgate Rock Dam to the Northern International Border, as would be expected, with only slight variations in the DO levels and pH values. An exception to the limited range of DO values was the Gila River. During the course of this study, flows were generally low (ca. 0.2 $m^3$/sec or 7 cfs) in this stream and an intensive algal bloom occurred. As a result, DO values varied from an early morning low of 2.6 mg/l to a daytime high of 25 mg/l.

## IV. APPLICATION TECHNIQUES, TYPES OF PESTICIDE MATERIALS USED AND CURRENT AGRICULTURAL PRACTICES

To maintain the high quality of their agricultural products and a high level of productivity, the farmers of the Lower Colorado River Basin depend heavily on pesticides to combat problems associated with insects, weeds and diseases.

Of the major pesticides applied in this area, about 75 percent by weight are applied by aircraft. In terms of acreage, about 65 to 85 percent is applied aerially.

In recent years, a significant increase in the use of organo-phosphate and carbamate pesticides, in addition to the continuing heavy use of organo-chlorine pesticides, has occurred. These changes have been brought about by: (1) the banning of DDT and related persistent compounds, (2) the need for more toxic substances to overcome tolerances attained by some species of pests, and (3) the widespread belief by farmers, distributors and applicators that the shorter-lived organo-phosphates are a lesser hazard to the environment. However, organo-chlorine use remains substantial, particularly upon cotton.

The total pesticides and herbicides applied to croplands within the five subject areas during 1972 are summarized as follows:

| Class of Compound | 1972 Applications | |
|---|---|---|
| | (kg) | (lb) |
| Organo-phosphorus | 814,000 | 1,794,000 |
| Organo-chlorine | 426,000 | 940,000 |
| OP-OC combinations | 87,000 | 192,000 |
| Carbamates | 502,000 | 1,106,000 |
| Herbicides | 530,000 | 1,169,000 |
| Total applications in 1972 | 2,359,000 | 5,201,000 |

By comparison, in 1968 about 454,000 kg (1,000,000 lb) of organo-chlorine and 45,400 kg (100,000 lb) of organo-phosphates were applied to the same areas. Minor use of carbamates prevailed at that time. Thus, use of organo-chlorines has remained nearly constant: use of organo-phosphates has increased 18-fold: and carbamate use has reached proportions comparable to total pesticide use in 1968.

The intensity of pesticide application, and thus the potential hazard to Colorado River water users, reaches a peak during the four months (July to October) of the cotton growing season. For example, estimated uses within the Arizona portion of the study area during the height of the 1972 and 1973 cotton seasons are summarized as follows:

| Class of Compound | Weight Applied July-Aug. 1972 | | Weight Applied July-Aug. 1973 | |
|---|---|---|---|---|
| | (kg) | (lb) | (kg) | (lb) |
| Organo-phosphorus | 134,600 | 296,700 | 138,400 | 305,100 |
| Organo-chlorine | 53,700 | 118,300 | 78,100 | 172,200 |
| Carbamates | 51,400 | 113,400 | 53,200 | 117,300 |
| Herbicides | 30,300 | 66,900 | 43,200 | 95,200 |
| | 270,000 | 595,300 | 312,900 | 689,800 |

While total pesticide usage has climbed upward, coupled with a significant increase in total irrigated land, changes in agricultural practices have taken place that appear to lessen the likelihood of environmental contamination.

A number of agricultural techniques are being employed to reduce the economic loss caused by insect pests, such as: (1) the use of better strains of pest-resistant crops as newer strains resist attacks from insects, suppress or destroy the insects, or tolerate insects

without loss of of vigor or yield: (2) planting a preferred host plant in with a desirable crop (e.g., a 16 to 32 ft wide strip of alfalfa across a cotton field to attract Lygus bugs); and (3) planting and harvesting earlier so that the crop is at a stage of development where major outbreaks of insect pests will do less damage, or the crop is harvested before major outbreaks occur.

Even though methods of control are slowly coming into general application, the use of chemicals still remains high. However, certain changes have taken place in recent years in the manner in which pesticides are used. The use of buffer zones between agricultural fields and water courses, more attention to spray drift and weather conditions, a more judicious selection of the material to be used, the proper timing of applications to catch the pests at their most vulnerable stage, and the apparent alleviation of the practice of disposal of unused pesticides in waters of the Basin have all contributed to lessening the hazard of pesticide contamination.

# V. METHODS AND MATERIALS

## A. BIOLOGY

Evaluation of AChE inhibition in channel catfish was accomplished by exposing the fish for 3- to 14-day intervals at 17 stations in the Lower Colorado River and the principal irrigation return drains.

Fish used in these studies were obtained from the California State Warm-Water Fish Hatchery at Niland. All were young-of-the-year, ranging in size from 5 cm (2 in.) to 11 cm (4 1/4 in.).

Upon receipt all fish were placed in pre-conditioning chambers located at Headgate Rock Dam and Yuma, Arizona (a procedure necessary due to the logistics of fish distribution).

After a 48 to 72 hr pre-conditioning period, 20 fish were placed in each of the 17 exposure cages. At given intervals, beginning three days after initial exposure, five fish were collected from each exposure cage and transported to laboratory facilities in Yuma, Arizona, where the brains were removed for AChE analysis. The final group of five fish was removed on the 14th day and another group of 20 fish replaced them.

Laboratory experiments at NFIC-D prior to the study demonstrated that a 14-day exposure was sufficient time to cause changes in AChE levels.

Principal equipment used for the AChE analysis was a Sargent* recording pH-stat. The technique used was that developed by the EPA Gulf Breeze Environmental Research Lab, Gulf Breeze, Florida. Briefly, the procedure is: brains of 5 fish from the same exposure site were pooled

---

*Mention of commercial products does not constitute endorsement by the U.S. Environmental Protection Agency.

wet weighed, and homogenized in distilled water. The brains were then further diluted with distilled water to a tissue concentration of 5 mg/ml. Four ml of the diluted homogenate were then mixed with 4 ml of 0.03 M acetylcholine iodide (which provides a specific base for the enzyme AChE). The pH-stat was then used to titrate liberated acetic acid with 0.01 N NaOH. The reaction was carried out at pH 7.0 and 22°C (72°F) (with a nitrogen purge over the surface of the reaction vessel to prevent absorption of atmospheric carbon dioxide).

Micromoles of acetylcholine hydrolyzed were calculated from the micromoles of NaOH required to neutralize the free acetic acid. AChE activity was expressed as micromoles of acetylcholine-hydrolyzed per hour per mg of brain tissue.

B. CHEMISTRY

Monitoring of the Lower Colorado River was accomplished by the use of continuous flow-through automatic samplers. These samplers were fabricated by NFIC-Denver personnel to collect both a continuous sample on a resin column and a liquid composite sample. Grab samples were collected to obtain background levels at selected locations.

Prior to the beginning of the Lower Colorado River field investigation, the performance of resin columns on pesticides recovery was tested. Among the relatively stable compounds tested (parathion, methyl parathion, and diazinon), recoveries after 48 hr ranged from 105 to 120 percent of grab samples subjected to conventional liquid/liquid extraction [Table 9] indicating that the resin columns performed at least as well as liquid/liquid extraction. Alkaline (pH 8.5)

solutions of phosdrin, furadan, zectran, carbaryl and diazinon degraded too rapidly to be recovered by the resin columns; however, these compounds were also undetectable in grab samples taken 12 hr after the solutions were mixed.

Samplers were installed at 10 key points in the study area [Figure 2 and Table 1]. A pump was installed near the sample source and the intake line, 2.5-cm galvanized iron pipe which had been cleaned with solvent, was laid into a well-mixed portion of the stream. The source water was then pumped into the sampling apparatus with a portion wasted downstream of the pump intake. Commercial electrical power was provided at all sampling locations with the exception of Station 5 near the mouth of the Colorado River Indian Reservation Lower Main Drain where a 3.5-KVA gasoline-driven generator was installed.

The flow in the sampling apparatus was directed through a three-way electric solenoid valve to the resin column, then into a constant head tank and metered through a metering device. Prior to this, the column was cleaned with a series of acetone rinses followed by a methylene chloride rinse and then filled as follows:

a) 5-cm polyurethane foam plug

b) 50 grams of a 50-50 mixture of Amberlite XAD-2 and XAD-7 resins

c) 10-cm polyurethane foam plug

d) glass wool filter

Water for the liquid composite sample was taken off the system at the three-way solenoid valve. The sample was pumped from the valve to a

19-liter (5 gal.) sampling container which had been placed in a refrigerated cabinet. Extraction solvent (0.9 liters of freon or methylene chloride) was initially added to the sampling collection container. The solvent and sample were mixed continuously by means of a magnetic stirrer. The temperature of the refrigerated cabinet was maintained at 10°C (50°F) to keep the extraction solvent from boiling off. Aliquots of sample (55 ml for a 72-hr composite and 80 ml for a 48-hr composite) were collected every 15 minutes. The time interval was controlled by a timer.

Extraction of the solvent from the composite water sample was made with a modified 1-liter Imhoff cone. The Imhoff cone was enlarged to accommodate a 2-liter sample and a teflon stopcock was attached to the bottom so that the extract could be drained off.

The sample extraction procedure used was as follows:

1. The Imhoff cone was cleaned by thoroughly rinsing with tap water followed by a careful rinse down the sides with 100 to 200 ml of acetone.

2. At the end of the sampling period, most of the water was discharged until only the solvent and about 500 to 700 ml of water were left. The amount of water poured off was measured and recorded.

3. The remaining solvent-water mixture was poured into the Imhoff cone and the two layers were allowed to separate for about one minute. The organic layer was emptied into a sample container. From 20 to 50 ml solvent was used to clean the sides of the Imhoff cone. This solvent was also decanted into the sample container.

4. The amount of water left in the cone was measured.

5. Sodium sulfate (50 grams) was added to the solvent carefully to avoid splashing. After the sodium sulfate was added, the cap was replaced and the container was shaken vigorously for 30 seconds.

6. The date, sample location, and volume of water in the composite sample were recorded on the bottle containing the solvent.

7. The sample was iced and transported to the NFIC-Denver laboratories for analysis.

Grab samples were collected in glass sample containers pre-rinsed in acetone and methylene chloride. Samples taken in the above containers were extracted with a freon or methylene chloride solvent. A 2-liter glass separatory funnel was used as the separation container. The sample extraction procedure used was as follows:

1. The separatory funnel was cleaned by adding 100 ml of solvent, mixed thoroughly, and drained through the stopcock. This procedure was done twice.

2. The water sample was poured from the sample bottle to the separatory funnel and 100 ml of solvent was used to rinse the sample bottle.

3. The two layers were allowed to separate and the solvent layer drained into a 250-ml sample bottle.

4. The extraction was repeated using 50 ml of solvent. When completed, this extract was added to the 250-ml sample bottle. Sodium sulfate (20 grams) was added, the sample iced and then shipped air freight to the NFIC-D laboratory for analysis.

## REFERENCES


1/ Investigation of Pesticide Pollution of the Interstate and International Waters of the Lower Colorado River Basin-A Preliminary Report., U.S. Department of the Interior, Federal Water Pollution Control Administration, Denver, Colo., 1968. Unpublished Report.

2/ Water Quality Standards for Surface Waters in Arizona, Arizona State Department of Health, Phoenix, Arizona., July, 1968.

3/ Water Quality Control Policy for the Colorado River in California, Colorado River Basin Regional Water Quality Control Board, Indio, California, March, 1967.

4/ Macek, K. J., Rogers, C.R., Stalling, D.L., and Korn, S., "The Uptake, Distribution, and Elimination of Dietary $^{14}$C-DDT and $^{14}$C-Dieldrin in Rainbow Trout", Transactions of the American Fisheries Society, 99 (4), 1970, pp 689-695.

5/ Bell, H. L., An Appraisal of Pesticide Usage and Surface Water Quality Effects in the United States, U.S. Environmental Protection Agency, National Field Investigations Center-Denver, Denver, Colo., 1974.

# APPENDIX

TABLE 1

SAMPLING STATIONS
LOWER COLORADO RIVER
PESTICIDE INVESTIGATION

| Sta. No. | Description | Type | Remarks |
|---|---|---|---|
| 1 | Colorado River upstream of Headgate Rock Dam | B[a/] C[b/] | Control station upstream of the study area |
| 2 | Colorado River upstream of CRIR Upper Main Drain[c/] | B | Representative of water quality in Colorado River upstream of CRIR Upper Main Drain |
| 3 | CRIR Upper Main Drain at mouth | BC | Drainage suspected of containing pesticides |
| 4 | Colorado River downstream from CRIR Upper Main Drain | B | Monitors effects of discharge of pesticides by CRIR Upper Main Drain |
| 5 | Colorado River upstream of CRIR Lower Main Drain | B | Representative of water quality in Colorado River upstream of CRIR Lower Main Drain |
| 6 | CRIR Lower Main Drain at mouth | BC | Drainage suspected of containing pesticides |
| 7 | Colorado River downstream from CRIR Lower Main Drain | B | Monitors effects of discharge of pesticides by CRIR Lower Main Drain |
| 8 | Colorado River upstream of PVID[d/] Drain | B | Representative of water quality in Colorado River upstream of PVID Drain |
| 9 | Palo Verde Drain at Highway 78 Crossing | BC | Drainage suspected of containing pesticides |
| 10 | Palo Verde Drain at mouth | B | Drainage suspected of containing pesticides |
| 11 | Colorado River downstream from PVID Drain | B | Monitors effects of discharge of pesticides by PVID Drain |
| 12 | Gila River near mouth | BC | Flow reconstituted by drainage from Welton-Mohawk Irrigation District and North Gila Valley. Suspected pesticide pollution source. |
| 13 | Colorado River at Yuma Water Treatment Plant Intake | BC | One of two sources of domestic water supply for Yuma Arizona. Water quality is affected by upstream irrigation drains. Representative of water quality upstream of Reservation Main Drain |
| 14 | Yuma Project Reservation Division Main Drain | BC | Drainage suspected of containing pesticides. |

TABLE 1 (Cont.)

SAMPLING STATIONS
LOWER COLORADO RIVER
PESTICIDE INVESTIGATION

| Sta. No. | Description | Type | Remarks |
|---|---|---|---|
| 15 | Colorado River downstream from Reservation Main Drain | B | Monitors effects of discharge of pesticides by Reservation Main Drain |
| 16 | Yuma Main Canal at Colorado River Siphon | C | One of two sources of domestic water supply for Yuma Arizona. Representative of water quality in All-American Canal which is domestic water supply for eleven communities in Southern California |
| 17 | Colorado River at the Northerly International Boundary | BC | Monitors effects of pesticide pollution sources within the study area. Evaluates pesticide content of Colorado River water entering Mexico. |
| 18 | Yuma Project Valley Division Main Drain | BC | Drainage suspected of containing pesticides. Drain crosses Southerly International Boundary near San Luis, Arizona-Sonora |
| 19 | Welton-Mohawk Drain at Yuma Water Treatment Plant | C | Drainage suspected of containing pesticides |

a/ Biological evaluation site.
b/ Chemical evaluation site.
c/ Colorado River Indian Reservation.
d/ Palo Verde Irrigation District.

TABLE 2

AChE ACTIVITY LEVELS OF EXPOSED CHANNEL CATFISH
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Sta. No. | Location | No. of Samples | Dates | No. of Fish Analyzed | AChE Activity[a/] Range | AChE Activity[a/] Mean |
|---|---|---|---|---|---|---|
| 1 | Headgate Rock Dam[b/] | 7 | 7/30-8/30 | 35 | 1.29-1.44 | 1.35 |
| 2 | Upstream of CRIR Upper Main Drain[b/] | 6 | 7/30-8/9 | 29 | 1.08-1.44 | 1.33 |
| 3 | CRIR Upper Main Drain | 9 | 7/30-9/9 | 47 | 1.26-1.44 | 1.37 |
| 4 | Downstream from CRIR Upper Main Drain[b/] | 4 | 8/16-9/9 | 17 | 1.11-1.42 | 1.29 |
| 5 | Upstream of CRIR Lower Main Drain[b/] | 7 | 7/30-9/9 | 32 | 1.08-1.47 | 1.33 |
| 6 | CRIR Lower Main Drain | 7 | 7/30-9/9 | 35 | 1.23-1.41 | 1.31 |
| 7 | Downstream from CRIR Lower Main Drain[b/] | 7 | 7/30-8/20 | 35 | 1.26-1.42 | 1.34 |
| 8 | Upstream of Palo Verde Drain[b/] | 9 | 7/30-9/9 | 46 | 1.29-1.42 | 1.36 |
| 9 | Palo Verde Drain at Hwy 78 | 10 | 7/30-9/9 | 50 | 1.14-1.47 | 1.33 |
| 10 | Palo Verde Drain at Mouth | 10 | 7/30-9/9 | 52 | 1.36-1.44 | 1.40 |
| 11 | Downstream from Palo Verde Drain[b/] | 10 | 7/30-9/9 | 49 | 1.2[illegible]-1.52 | 1.38 |
| 13 | Colorado River at Yuma Water Treatment Plant Intake[b/] | 11 | 7/22-9/9 | 57 | 1.34-1.59 | 1.43 |
| 14 | Yuma Project Reservation Main Drain | 13 | 7/23-9/9 | 66 | 1.32-1.53 | 1.41 |
| 15 | Downstream from Yuma Project Reservation Main Drain[b/] | 11 | 7/22-9/9 | 63 | 1.30-1.52 | 1.42 |
| 17 | Northerly International Boundary[b/] | 12 | 7/22-9/3 | 66 | 1.27-1.53 | 1.39 |
| 18 | Yuma Project Valley Main Drain at San Luis | 11 | 7/22-9/9 | 54 | 1.22-1.42 | 1.31 |
| | Control - Unexposed | 63 | 7/19-9/9 | 313 | 1.21-1.66 | 1.41 |
| | TOTALS (Excluding Control) | 144 | | 733 | 1.08-1.59 | 1.37 |

a/ Expressed as micromoles of acetycholine hydrolized per hour per milligram of brain tissue.
b/ Stations on the Colorado River.

TABLE 3

PESTICIDE RESIDUE ANALYSES OF NATIVE FISH
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Location | Date Collected | Species | No. Fish per Sample | Pesticide Concentration (Whole Fish) (ug/g) |
|---|---|---|---|---|
| Upstream of Palo Verde Diversion Dam[a/] | 8/23/73 | Largemouth Bass | 1 | ND[b/] |
| Upstream of Palo Verde Diversion Dam | 8/23/73 | Buffalo | 2 | ND |
| Upstream of Imperial Dam[a/] | 8/23/73 | Bluegill | 1 | ND |
| Mittry Lake | 7/16/73 | Largemouth Bass | 2 | ND |
| Mittry Lake | 7/16/73 | Channel Catfish | 2 | ND |
| Yuma Project Valley Division Main Drain | 7/16/73 | Largemouth Bass | 1 | 0.30 (DDT) |
| Yuma Project Valley Division Main Drain | 7/16/73 | Bluegill | 1 | ND |
| Yuma Project Valley Division Main Drain | 7/16/73 | Smallmouth Bass | 2 | 0.36 (DDT) |
| Yuma Project Valley Division Main Drain | 7/16/73 | Buffalo | 2 | 0.18 (DDT) |

a/ Stations on the Colorado River.
b/ ND = None Detected.

TABLE 4

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration[a] |
|---|---|---|---|---|
| | | CRIR Upper Main Drain (Station No. 3) | | |
| 7/20 | Resin Col. | 48 | 102 | ND[b] |
| 7/23 | Resin Col. | 72 | 155 | ND |
| 7/25 | Resin Col. | 48 | 113 | ND |
| 7/27 | Resin Col. | 48 | 101 | ND |
| 7/30 | Resin Col. | 72 | 157 | ND |
| 8/01 | Resin Col. | 48 | 108 | ND |
| 8/03 | Resin Col. | 48 | 107 | ND |
| 8/06 | Resin Col. | 72 | 110 | ND |
| 8/08 | Resin Col. | 48 | 116 | ND |
| 8/10 | Resin Col. | 48 | 103 | ND |
| 8/13 | Resin Col. | 72 | 167 | NA[c] |
| 8/15 | Resin Col. | 48 | 117 | ND |
| 8/17 | Resin Col. | 48 | 50 | ND |
| 8/22 | Resin Col. | 48 | 106 | ND |
| 8/22 | Liq. Comp. | 48 | 20 | ND |
| 8/24 | Resin Col. | 48 | 105 | ND |
| 8/24 | Liq. Comp. | 48 | 14.8 | ND |
| 8/27 | Resin Col. | 72 | 247 | NA |
| 8/27 | Liq. Comp. | 72 | 18.5 | NA |
| 8/29 | Resin Col. | 48 | 132 | ND |
| 8/29 | Liq. Comp. | 48 | 13 | ND |
| 8/31 | Resin Col. | 48 | 122 | ND |
| 8/31 | Liq. Comp. | 48 | 8.0 | ND |
| 9/03 | Resin Col. | 72 | 189 | NA |
| 9/03 | Liq. Comp. | 72 | 16.2 | NA |
| 9/05 | Resin Col. | 48 | 73 | ND |
| 9/07 | Resin Col. | 48 | 75 | ND |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration[a/] |
|---|---|---|---|---|
| | | CRIR Lower Main Drain (Station No. 6) | | |
| 7/20 | Resin Col. | 48 | 28 | ND |
| 7/20 | Liq. Comp. | 48 | 11.2 | SL[d/] |
| 7/25 | Resin Col. | 48 | 22 | ND |
| 7/25 | Liq. Comp. | 48 | 2.6 | NA |
| 7/27 | Resin Col. | 48 | 29 | ND |
| 7/27 | Liq. Comp. | 48 | 2.6 | ND |
| 8/01 | Resin Col. | 48 | 73 | ND |
| 8/01 | Liq. Comp. | 48 | 12.2 | ND |
| 8/03 | Resin Col. | 48 | 42 | ND |
| 8/03 | Liq. Comp. | 48 | 7.5 | NA |
| 8/08 | Resin Col. | 48 | 26 | ND |
| 8/15 | Resin Col. | 48 | 21 | ND |
| 8/15 | Liq. Comp. | 48 | 8 | ND |
| 8/17 | Resin Col. | 48 | 31 | ND |
| 8/17 | Liq. Comp. | 48 | 20 | ND |
| 8/22 | Resin Col. | 48 | 56 | ND |
| 8/24 | Resin Col. | 48 | 43 | ND |
| 8/24 | Liq. Comp. | 48 | 8.1 | NA |
| 8/27 | Resin Col. | 72 | 96 | NA |
| 8/31 | Resin Col. | 48 | 48 | ND |
| 8/31 | Liq. Comp. | 48 | 7.2 | NA |
| 9/03 | Resin Col. | 72 | 78 | NA |
| 9/03 | Liq. Comp. | 72 | 10.0 | NA |
| 9/05 | Resin Col. | 48 | 64 | ND |
| 9/05 | Liq. Comp. | 48 | 8.0 | NA |
| 9/07 | Resin Col. | 48 | 38 | ND |
| 9/07 | Liq. Comp. | 48 | 5.5 | ND |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Palo Verde Drain (Station No. 10) | | |
| 7/27 | Resin Col. | 48 | 51 | ND |
| 7/30 | Resin Col. | 72 | 165 | ND |
| 8/01 | Resin Col. | 48 | 82 | ND |
| 8/01 | Liq. Comp. | 48 | 12 | ND |
| 8/03 | Resin Col. | 48 | 101 | ND |
| 8/06 | Resin Col. | 72 | 154 | ND |
| 8/08 | Resin Col. | 48 | 90 | ND |
| 8/08 | Liq. Comp. | 48 | 13 | NA |
| 8/10 | Resin Col. | 48 | 112 | ND |
| 8/10 | Liq. Comp. | 48 | 13 | NA |
| 8/13 | Resin Col. | 72 | 154 | NA |
| 8/13 | Liq. Comp. | 72 | 14 | NA |
| 8/15 | Resin Col. | 48 | 83 | ND |
| 8/15 | Liq. Comp. | 48 | 12 | NA |
| 8/17 | Resin Col. | 48 | 117 | ND |
| 8/17 | Liq. Comp. | 48 | 18.5 | ND |
| 8/20 | Resin Col. | 72 | 160 | NA |
| 8/20 | Liq. Comp. | 72 | 14 | NA |
| 8/22 | Resin Col. | 48 | 97 | ND |
| 8/22 | Liq. Comp. | 48 | 14 | NA |
| 8/24 | Resin Col. | 48 | 103 | ND |
| 8/24 | Liq. Comp. | 48 | 14.8 | NA |
| 8/27 | Resin Col. | 72 | 140 | NA |
| 8/27 | Liq. Comp. | 72 | 16.5 | NA |
| 8/29 | Resin Col. | 48 | 92 | ND |
| 8/31 | Resin Col. | 48 | 84 | ND |
| 8/31 | Liq. Comp. | 48 | 16.5 | NA |
| 9/03 | Resin Col. | 72 | 152 | NA |
| 9/03 | Liq. Comp. | 72 | 14.5 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration[a/] |
|---|---|---|---|---|
| | Palo Verde Drain (Cont.) (Station No. 10) | | | |
| 9/05 | Resin Col. | 48 | 89 | ND |
| 9/05 | Liq. Comp. | 48 | 12.0 | NA |
| 9/07 | Resin Col. | 48 | 191 | ND |
| 9/07 | Liq. Comp. | 48 | 16.5 | NA |
| | Gila River near Mouth (Station No. 12) | | | |
| 8/03 | Resin Col. | 48 | 75 | ND |
| 8/03 | Liq. Comp. | 48 | 14.0 | NA |
| 8/06 | Resin Col. | 72 | 65 | ND |
| 8/06 | Liq. Comp. | 72 | 14.5 | NA |
| 8/08 | Resin Col. | 48 | 85 | ND |
| 8/08 | Liq. Comp. | 48 | 15.0 | NA |
| 8/10 | Resin Col. | 48 | 102 | ND |
| 8/10 | Liq. Comp. | 48 | 15.0 | NA |
| 8/13 | Resin Col. | 72 | 162 | NA |
| 8/13 | Liq. Comp. | 72 | 10.0 | NA |
| 8/15 | Resin Col. | 48 | 85 | ND |
| 8/15 | Liq. Comp. | 48 | 13 | ND |
| 8/17 | Resin Col. | 48 | 95 | ND |
| 8/17 | Liq. Comp. | 48 | 9.0 | ND |
| 8/20 | Resin Col. | 72 | 0 | ND |
| 8/20 | Liq. Comp. | 72 | 10.5 | NA |
| 8/24 | Resin Col. | 48 | 94 | ND |
| 8/24 | Liq. Comp. | 48 | 16.5 | NA |
| 8/27 | Resin Col. | 72 | 74 | NA |
| 8/29 | Resin Col. | 48 | 86 | ND |
| 8/29 | Liq. Comp. | 48 | 13 | NA |
| 8/31 | Resin Col. | 48 | 96 | ND |
| 8/31 | Liq. Comp. | 48 | 16 | NA |
| 9/03 | Resin Col. | 72 | 137 | NA |
| 9/03 | Liq. Comp. | 72 | 15 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Colorado River at Yuma Water Treatment Plant Intake (Station No. 13) | | |
| 7/20 | Resin Col. | 48 | 122 | ND |
| 7/20 | Liq. Comp. | 48 | 15.2 | NA |
| 7/23 | Resin Col. | 72 | 148 | ND |
| 7/23 | Liq. Comp. | 72 | 13.2 | NA |
| 7/25 | Resin Col. | 48 | 104 | ND |
| 7/25 | Liq. Comp. | 48 | 16.1 | ND |
| 8/15 | Resin Col. | 48 | 120 | ND |
| 8/15 | Liq. Comp. | 48 | 14.0 | NA |
| 8/20 | Resin Col. | 48 | 96 | ND |
| 8/22 | Resin Col. | 48 | 116 | ND |
| 8/22 | Liq. Comp. | 48 | 18.0 | NA |
| 8/24 | Resin Col. | 48 | 113 | ND |
| 8/24 | Liq. Comp. | 48 | 4 | NA |
| 8/27 | Resin Col. | 72 | 169 | NA |
| 8/27 | Liq. Comp. | 72 | 15 | NA |
| 9/05 | Resin Col. | 48 | 111 | ND |
| 9/05 | Liq. Comp. | 48 | 16 | NA |
| 9/07 | Resin Col. | 48 | 119 | ND |
| 9/07 | Liq. Comp. | 48 | 17 | NA |
| | | Welton-Mohawk Drain at Yuma Water Treatment Plant (Station No. 19) | | |
| 7/27 | Resin Col. | 48 | 89 | ND |
| 7/27 | Liq. Comp. | 48 | 14 | NA |
| 7/30 | Resin Col. | 72 | 133 | ND |
| 7/30 | Liq. Comp. | 72 | 9.5 | NA |
| 8/01 | Resin Col. | 48 | 224 | ND |
| 8/01 | Liq. Comp. | 48 | 12.0 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Welton Mohawk Drain at (Cont.) Yuma Water Treatment Plant (Station No. 19) | | |
| 8/03 | Resin Col. | 48 | 201 | ND |
| 8/03 | Liq. Comp. | 48 | 11.0 | NA |
| 8/06 | Resin Col. | 72 | 173 | ND |
| 8/06 | Liq. Comp. | 72 | 17.0 | NA |
| 8/08 | Resin Col. | 48 | 130 | ND |
| 8/08 | Liq. Comp. | 48 | 15.0 | NA |
| 8/10 | Resin Col. | 48 | 141 | ND |
| 8/10 | Liq. Comp. | 48 | 9.0 | NA |
| 8/13 | Resin Col. | 72 | 197 | NA |
| 8/13 | Liq. Comp. | 72 | 15.5 | NA |
| 8/29 | Resin Col. | 48 | 78 | ND |
| 8/29 | Liq. Comp. | 48 | 14 | NA |
| 8/31 | Resin Col. | 48 | 110 | ND |
| 8/31 | Liq. Comp. | 48 | 13 | NA |
| 9/03 | Resin Col. | 72 | 166 | NA |
| 9/03 | Liq. Comp. | 72 | 10 | NA |
| | | Yuma Project Reservation Main Drain (Station No. 14) | | |
| 7/23 | Resin Col. | 72 | 132 | ND |
| 7/23 | Liq. Comp. | 72 | 9.5 | NA |
| 7/25 | Resin Col. | 48 | 101 | ND |
| 7/25 | Liq. Comp. | 48 | 8.6 | NA |
| 7/27 | Resin Col. | 48 | 103 | ND |
| 7/27 | Liq. Comp. | 48 | 8.1 | NA |
| 7/30 | Resin Col. | 72 | 154 | ND |
| 7/30 | Liq. Comp. | 72 | 14.0 | NA |
| 8/01 | Resin Col. | 48 | 100 | ND |
| 8/01 | Liq. Comp. | 48 | 16.0 | ND |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Yuma Project Reservation Main Drain (Cont.) (Station No. 14) | | |
| 8/03 | Resin Col. | 48 | 103 | ND |
| 8/03 | Liq. Comp. | 48 | 19 | ND |
| 8/06 | Resin Col. | 72 | 147 | ND |
| 8/06 | Liq. Comp. | 72 | 16.4 | NA |
| 8/08 | Resin Col. | 48 | 100 | ND |
| 8/08 | Liq. Comp. | 48 | 15.1 | ND |
| 8/10 | Resin Col. | 48 | 103 | ND |
| 8/10 | Liq. Comp. | 48 | 16.0 | ND |
| 8/13 | Resin Col. | 72 | 157 | NA |
| 8/13 | Liq. Comp. | 72 | 19.0 | NA |
| 8/15 | Resin Col. | 48 | 107 | ND |
| 8/15 | Liq. Comp. | 48 | 18.5 | NA |
| 8/17 | Resin Col. | 48 | 99 | ND |
| 8/17 | Liq. Comp. | 48 | 17.5 | ND |
| 8/20 | Resin Col. | 72 | 131 | NA |
| 8/20 | Liq. Comp. | 72 | 13 | NA |
| 8/22 | Resin Col. | 48 | 100 | ND |
| 8/22 | Liq. Comp. | 48 | 16.0 | NA |
| 8/24 | Resin Col. | 48 | 99 | ND |
| 8/24 | Liq. Comp. | 48 | 18 | NA |
| 8/27 | Resin Col. | 72 | 148 | NA |
| 8/27 | Liq. Comp. | 72 | 18 | NA |
| 8/29 | Resin Col. | 48 | 96 | ND |
| 8/29 | Liq. Comp. | 48 | 10 | NA |
| 8/31 | Resin Col. | 48 | 68 | ND |
| 8/31 | Liq. Comp. | 48 | 13 | NA |
| 9/03 | Resin Col. | 72 | 133 | NA |
| 9/03 | Liq. Comp. | 72 | 13 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Yuma Project Reservation Main Drain (Cont.) (Station No. 14) | | |
| 9/05 | Resin Col. | 48 | 95 | ND |
| 9/05 | Liq. Comp. | 48 | 16.5 | NA |
| 9/07 | Resin Col. | 48 | 99 | ND |
| 9/07 | Liq. Comp. | 48 | 14 | NA |
| | | Yuma Main Canal at Colorado River Siphon (Station No. 16) | | |
| 7/20 | Resin Col. | 48 | 88 | ND |
| 7/20 | Liq. Comp. | 48 | 15.0 | NA |
| 7/23 | Resin Col. | 72 | 149 | ND |
| 7/23 | Liq. Comp. | 72 | 13.0 | NA |
| 7/25 | Resin Col. | 48 | 97 | ND |
| 7/25 | Liq. Comp. | 48 | 16.0 | NA |
| 7/27 | Resin Col. | 48 | 97 | ND |
| 7/27 | Liq. Comp. | 48 | 15 | NA |
| 7/30 | Resin Col. | 72 | 142 | NA |
| 7/30 | Liq. Comp. | 72 | 13.0 | NA |
| 8/01 | Resin Col. | 48 | 99 | ND |
| 8/01 | Liq. Comp. | 48 | 15.5 | NA |
| 8/03 | Resin Col. | 48 | 101 | ND |
| 8/03 | Liq. Comp. | 48 | 15.6 | NA |
| 8/06 | Resin Col. | 72 | 146 | ND |
| 8/06 | Liq. Comp. | 72 | 14.6 | NA |
| 8/08 | Resin Col. | 48 | 99 | ND |
| 8/08 | Liq. Comp. | 48 | 14.5 | NA |
| 8/10 | Resin Col. | 48 | 99 | ND |
| 8/10 | Liq. Comp. | 48 | 9.5 | NA |
| 8/13 | Resin Col. | 72 | 155 | NA |
| 8/13 | Liq. Comp. | 72 | 14.5 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Yuma Main Canal at Colorado River Siphon (Cont.) (Station No. 16) | | |
| 8/15 | Resin Col. | 48 | 108 | ND |
| 8/15 | Liq. Comp. | 48 | 17.0 | NA |
| 8/17 | Resin Col. | 48 | 101 | ND |
| 8/17 | Liq. Comp. | 48 | 19.0 | NA |
| 8/20 | Resin Col. | 72 | 153 | ND |
| 8/20 | Liq. Comp. | 72 | 11 | NA |
| 8/22 | Resin Col. | 48 | 98 | ND |
| 8/22 | Liq. Comp. | 48 | 16.0 | NA |
| 8/24 | Resin Col. | 48 | 99 | ND |
| 8/24 | Liq. Comp. | 48 | 16.5 | NA |
| 8/27 | Resin Col. | 72 | 146 | NA |
| 8/27 | Liq. Comp. | 72 | 16 | NA |
| 8/29 | Resin Col. | 48 | 182 | ND |
| 8/29 | Liq. Comp. | 48 | 14 | NA |
| 8/31 | Resin Col. | 48 | 106 | ND |
| 8/31 | Liq. Comp. | 48 | 15 | NA |
| 9/03 | Resin Col. | 48 | 129 | ND |
| 9/03 | Liq. Comp. | 48 | 14 | NA |
| 9/07 | Resin Col. | 48 | 133 | ND |
| | | Colorado River at Northern International Border (Station No. 17) | | |
| 7/23 | Resin Col. | 48 | 48 | ND |
| 7/23 | Liq. Comp. | 48 | 17.5 | NA |
| 7/25 | Resin Col. | 48 | 82 | ND |
| 7/25 | Liq. Comp. | 48 | 16.0 | NA |
| 7/27 | Resin Col. | 48 | 90 | ND |
| 7/27 | Liq. Comp. | 48 | 16.0 | ND |
| 7/30 | Resin Col. | 72 | 148 | NA |
| 7/30 | Liq. Comp. | 72 | 17.5 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | Colorado River at Northern International Border (Cont.) (Station No. 17) | | | |
| 8/01 | Resin Col. | 48 | 93 | ND |
| 8/01 | Liq. Comp. | 48 | 16.1 | NA |
| 8/03 | Resin Col. | 48 | 110 | ND |
| 8/03 | Liq. Comp. | 48 | 16.3 | NA |
| 8/06 | Resin Col. | 72 | 131 | ND |
| 8/06 | Liq. Comp. | 72 | 13.0 | NA |
| 8/08 | Resin Col. | 48 | 74 | ND |
| 8/08 | Liq. Comp. | 48 | 8.3 | NA |
| 8/10 | Resin Col. | 48 | 76 | ND |
| 8/13 | Resin Col. | 72 | 24 | NA |
| 8/15 | Resin Col. | 48 | 107 | ND |
| 8/17 | Resin Col. | 48 | 55 | ND |
| 8/20 | Resin Col. | 72 | 124 | NA |
| 8/22 | Resin Col. | 48 | 91 | ND |
| 8/24 | Resin Col. | 48 | 110 | ND |
| 8/27 | Resin Col. | 72 | 148 | NA |
| 8/29 | Resin Col. | 48 | 96 | ND |
| 8/31 | Resin Col. | 48 | 102 | ND |
| 9/03 | Resin Col. | 72 | 128 | NA |
| 9/05 | Resin Col. | 48 | 91 | ND |
| 9/07 | Resin Col. | 48 | 95 | ND |
| | Yuma Project Valley Division Main Drain at San Luis (Station No. 18) | | | |
| 7/20 | Resin Col. | 48 | 82 | ND |
| 7/20 | Liq. Comp. | 48 | 8.8 | NA |
| 7/23 | Resin Col. | 72 | 158 | ND |
| 7/23 | Liq. Comp. | 72 | 14 | NA |
| 7/25 | Resin Col. | 48 | 82 | ND |
| 7/25 | Liq. Comp. | 48 | 12.8 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (liters) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | | Yuma Project Valley Division Main Drain at San Luis (Cont.) (Station No. 18) | | |
| 7/27 | Resin Col. | 48 | 109 | NA |
| 7/27 | Liq. Comp. | 48 | 19 | NA |
| 7/30 | Resin Col. | 72 | 142 | ND |
| 7/30 | Liq. Comp. | 72 | 15.5 | NA |
| 8/01 | Resin Col. | 48 | 79 | ND |
| 8/01 | Liq. Comp. | 48 | 15.5 | ND |
| 8/03 | Resin Col. | 48 | 122 | ND |
| 8/03 | Liq. Comp. | 48 | 15.5 | ND |
| 8/06 | Resin Col. | 72 | 159 | ND |
| 8/06 | Liq. Comp. | 72 | 16.5 | NA |
| 8/08 | Resin Col. | 48 | 98 | ND |
| 8/08 | Liq. Comp. | 48 | 10.4 | ND |
| 8/10 | Resin Col. | 48 | 96 | ND |
| 8/10 | Liq. Comp. | 48 | 8.0 | ND |
| 8/13 | Resin Col. | 72 | 142 | NA |
| 8/13 | Liq. Comp. | 72 | 7.0 | NA |
| 8/15 | Resin Col. | 48 | 97 | ND |
| 8/15 | Liq. Comp. | 48 | 19.5 | NA |
| 8/17 | Resin Col. | 48 | 92 | ND |
| 8/17 | Liq. Comp. | 48 | 18.5 | NA |
| 8/20 | Resin Col. | 72 | 118 | ND |
| 8/20 | Liq. Comp. | 72 | 12.0 | NA |
| 8/22 | Resin Col. | 48 | 45 | ND |
| 8/24 | Resin Col. | 48 | 97 | ND |
| 8/27 | Resin Col. | 72 | 138 | NA |
| 8/29 | Resin Col. | 48 | 98 | ND |
| 8/29 | Liq. Comp. | 48 | 16 | NA |
| 8/31 | Resin Col. | 48 | 87 | ND |
| 8/31 | Liq. Comp. | 48 | 7 | NA |

TABLE 4 (Cont.)

RESULTS OF RESIN COLUMN AND LIQUID COMPOSITE ANALYSES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Beginning Date | Type of Sample | Duration (hr) | Volume of Water Sampled (litres) | Pesticides Concentration a/ |
|---|---|---|---|---|
| | Yuma Project Valley Division Main Drain at San Luis (Cont.) (Station No. 18) | | | |
| 9/03 | Resin Col. | 72 | 139 | NA |
| 9/03 | Liq. Comp. | 72 | 19 | NA |
| 9/05 | Resin Col. | 48 | 84 | ND |
| 9/05 | Liq. Comp. | 48 | 13 | NA |
| 9/07 | Resin Col. | 48 | 98 | ND |
| 9/07 | Liq. Comp. | 48 | 15 | NA |

a/ Results above background and blanks of gas chromatographic analyses using EC, AP, and Coulson detectors.
b/ None Detected.
c/ Not Analyzed. Samples not analyzed were collected to insure that sufficient samples would be available for additional analyses if high pesticide concentrations were detected.
d/ This sample was lost during analysis.

TABLE 5

RESULTS OF ANALYSES OF WATER CRAB SAMPLES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Location | Date | Results of GC Analysis |
|---|---|---|
| Headgate Rock Dam[a/] | 7/17 | ND[b/] |
| Headgate Rock Dam[a/] | 8/22 | ND |
| Headgate Rock Dam[a/] | 9/09 | ND |
| Gaging Station CRIR Upper Main Drain | 7/19 | ND |
| Upstream of Canal Spillway at CRIR Upper Main Drain | 7/19 | ND |
| Upstream of Confluence with Gila River[a/] | 7/17 | ND |
| Upstream of Confluence with Gila River[a/] | 8/19 | ND |
| All American Canal at Control Structure Settling Basin | 7/18 | ND |
| All American Canal at Control Structure Settling Basin | 8/19 | ND |
| All American Canal at Control Structure Settling Basin | 9/08 | ND |
| Colorado River Upstream of Imperial Dam[a/] | 7/18 | ND |
| Colorado River Upstream of Imperial Dam[a/] | 8/19 | ND |
| Colorado River Upstream of Imperial Dam[a/] | 9/08 | ND |
| Colorado River Downstream from[a/] Imperial Dam | 7/18 | ND |
| Colorado River Downstream from[a/] Imperial Dam | 8/19 | ND |
| Colorado River Downstream from[a/] Imperial Dam | 9/08 | ND |
| Colorado River at No. 4 Outfall[a/] of Desilting Works | 7/19 | ND |
| Colorado River at No. 4 Outfall[a/] of Desilting Works | 8/19 | ND |
| Colorado River at No. 4 Outfall[a/] of Desilting Works | 9/08 | ND |

a/ Stations on the Colorado River.
b/ None detected.

TABLE 6

RESULTS OF PESTICIDES ANALYSES
TILE DRAINAGE
LOWER COLORADO RIVER

| Sample No. | Source | Date Taken | Volume (ml) | Pesticides |
|---|---|---|---|---|
| BC #1 | Bill Chrismer Farms #1 Tile Drain | 11-5-73 | 938 | ND[a/] |
| BC #2 | Bill Chrismer Farms #2 Tile Drain | 11-5-73 | 925 | ND |
| DF #1 | Dana Fisher Farm Tile Dr. Sump PVID | 11-5-73 | 830 | ND |
| JN #1 | John Norton Farms PVID Sec. 32T75R23E Tile Drain Sump | 11-5-73 | 895 | ND |
| CRIT #1 | Tile Drain to Lower Main Drain | 11-5-73 | 883 | ND |
| LMD #1 | CRIR Lower Main Dr. Near Mouth | 11-5-73 | 879 | ND |
| PVD #1 | Palo Verde Outfall Dr. at Palo Verde | 11-5-73 | 905 | ND |

a/ None detected.

TABLE 7

RESULTS OF SEDIMENT ANALYSES FOR TOXAPHENE RESIDUES
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Location | Date | Results of GC Analysis[a/] |
|---|---|---|
| CRIR Upper Main Drain | 9/09 | 34% water<br>No Toxaphene detected |
| CRIR Lower Main Drain | 9/09 | 36% water<br>No Toxaphene detected |
| Palo Verde Drain | 9/09 | 39% water<br>No Toxaphene detected |
| Gila River near Mouth | 9/08 | 52% water<br>No Toxaphene detected |
| Colorado River at Yuma Water Treatment Plant Intake | 9/08 | 24% water<br>No Toxaphene detected |
| Colorado River Downstream from Yuma Project Reservation Main Drain | 9/08 | 32% water<br>No Toxaphene detected |
| Colorado River at Northern International Border | 9/08 | 25% water<br>No Toxaphene detected |
| Yuma Project Valley Main Drain at San Luis | 9/08 | 22% water<br>No Toxaphene detected |

a/ Water analysis by weight loss.

WATER QUALITY DATA
LOWER COLORADO RIVER BASIN
JULY TO SEPTEMBER 1973

| Station No. | Location | | Temperature (°C) | pH | Dissolved Oxygen (mg/l) |
|---|---|---|---|---|---|
| 1 | Headgate Rock Dam[a/] | Avg | 25.0 | | 7.2 |
| | | Range | 22.0-28.0 | 7.2-8.4 | 6.4-8.3 |
| 2 | Upstream of CRIR Upper Main Drain[a/] | Avg | 27.0 | | 8.1 |
| | | Range | 23.0-31.0 | 7.5-8.6 | 6.4-9.4 |
| 3 | CRIR Upper Main Drain at Mouth | Avg | 26.0 | | 7.2 |
| | | Range | 22.0-30.0 | 7.5-8.1 | 4.8-8.8 |
| 4 | Downstream from CRIR Upper Main Drain[a/] | Avg | 26.0 | | 7.3 |
| | | Range | 23.0-29.0 | 7.4-8.1 | 5.5-9.0 |
| 5 | Upstream of CRIR Lower Main Drain[a/] | Avg | 26.8 | | 8.2 |
| | | Range | 23.5-30.0 | 7.4-8.6 | 6.4-9.7 |
| 6 | CRIR Lower Main Drain at Mouth | Avg | 26.5 | | 7.4 |
| | | Range | 23.0-30.0 | 7.2-8.2 | 5.4-9.2 |
| 7 | Downstream from CRIR Lower Main Drain[a/] | Avg | 28.0 | | 7.1 |
| | | Range | 26.0-30.0 | 7.3-8.2 | 6.2-8.4 |
| 8 | Upstream of Palo Verde Drain[b/] | Avg | 27.5 | | 7.9 |
| | | Range | 25.0-30.0 | 7.3-8.4 | 6.0-10.2 |
| 9 | Palo Verde Drain at Hwy 78 | Avg | 29.0 | | 7.0 |
| | | Range | 25.0-33.0 | 6.9-8.1 | 5.2-7.9 |
| 10 | Palo Verde Drain at Mouth | Avg | 29.0 | | 8.3 |
| | | Range | 26.0-32.0 | 7.5-8.4 | 5.7-11.0 |
| 11 | Downstream from Palo Verde Drain[a/] | Avg | 28.5 | | 8.1 |
| | | Range | 26.0-31.0 | 7.7-8.4 | 6.3-10.5 |
| 12 | Gila River near Mouth | Avg | 31.0 | | 11.4 |
| | | Range | 25.0-37.0 | 7.5-8.6 | 2.6-25.0 |
| 13 | Colorado River at Yuma Water Treatment Plant Intake[a/] | Avg | 28.5 | | 7.1 |
| | | Range | 24.0-33.0 | 7.2-8.2 | 5.9-8.4 |
| 14 | Yuma Project Reservation Main Drain | Avg | 25.7 | | 6.5 |
| | | Range | 21.0-30.5 | 7.2-8.2 | 5.2-9.2 |
| 15 | Downstream from Yuma Project Reservation Main Drain[a/] | Avg | 29.0 | | 6.8 |
| | | Range | 25.0-33.0 | 7.1-8.2 | 4.0-10.1 |
| 16 | Yuma Main Canal at Siphon | Avg | 28.0 | | 8.- |
| | | Range | 25.0-31.0 | 7.1-8.2 | 7.1-10.4 |
| 17 | Northern International Border[a/] | Avg | 29.0 | | 7.0 |
| | | Range | 25.0-33.0 | 7.4-8.0 | 5.1-9.5 |
| 18 | Yuma Project Valley Main Drain at San Luis | Avg | 30.0 | | 6.9 |
| | | Range | 26.0-34.0 | 7.3-8.1 | 5.7-9.0 |
| 19 | Welton-Mohawk Canal at Yuma Water Treatment Plant | Avg | 26.5 | | 8.4 |
| | | Range | 23.0-30.0 | 7.4-8.3 | 6.8-10.7 |

a/ Stations on the Colorado River.

TABLE 9

EFFICIENCY OF RESIN COLUMNS FOR
RECOVERY OF PESTICIDES
(0.1 mg/l SOLUTIONS) FROM WATER

FIRST TRIAL

| Compound | Recovery % Day 1 | Day 11 |
|---|---|---|
| parathion | 95 | 120[a/] |
| phosdrin | b/ | b/ |
| furadan | b/ | b/ |
| zectran | b/ | b/ |
| carbaryl | b/ | b/ |

SECONDARY TRIAL

| | | |
|---|---|---|
| parathion | 97 | 108 |
| methyl parathion | 114 | 105 |
| thimet | b/ | b/ |
| diazinon | 121 | 114 |

a/ Recoveries greater than 100 percent indicate that recoveries with the resin columns were equal to or greater than those obtained by conventional L/L extraction.

b/ These compounds degraded too rapidly to yield useful results. In all cases, the compounds had entirely or nearly disappeared by the second grab sample (12 hours after addition of the pesticide). The pH of the water was approximately 8.5.